Forest Health Protection

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Jerry Johnson Campground Hazard Tree Evaluation
September 2003

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Summary

Trees in and near camping sites, campground roads and other developed features of Jerry Johnson Campground were mapped and scored for damage, defect and hazard in September 2003. A total of 24 camping unit or other developed sites were assessed. 843 trees were examined, 25 of which were dead. Nearly all of the trees were mature and some were very large. Grand fir was the most abundant species constituting 88% of the trees examined. Douglas-fir, lodgepole pine and ponderosa pine were also present. Root disease was moderate to severe in 33% of the trees and stem decay was rated moderate to severe in 5% of trees. Wounding, mostly recent, was seen in 30% of trees.

Monitoring or removal was recommended for trees according to the severity of their damage or defect, the likelihood that a damage or defect may lead to tree failure, and the probability that a failed tree or part of tree would strike a structure or an occupied site. Removal was recommended for 169 trees (145 live trees).

They ranged from less than 8 inches d.b.h. to nearly 37 inches. Most were grand fir or Douglas-fir and most had severe root disease, often with bark beetle or ambrosia beetle infestation as well.

A yearly walk-through exam is recommended for this campground with another full assessment in 5 years. The map and database we developed in this assessment should make re-assessment of these trees relatively easy. A vegetation management plan that includes regeneration of root disease resistant tree species is highly recommended. In should facilitate vegetation rehabilitation to compensate for continuing high rates of root disease-related tree removal.

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General condition of trees in the campground

Jerry Johnson Campground is located on Idaho State Highway 12 in the wild and scenic river corridor between the-Idaho Montana border and the confluence of Lochsa and Selway Rivers (approximately 75 miles upriver from Kooskia, Idaho). It is a historic use campground that has recently been expanded and renovated. Like nearly all of the forests along the Lochsa River, the stand in which Jerry Johnson campground is built is mostly mature grand fir/ Douglas-fir. Root disease caused by *Heterobasidion annosum* (primarily), and some *Armillaria ostoyae,* is evident throughout. Butt rot, likely caused by H. annosum is a common occurrence in grand fir scattered throughout the campground. Fir engraver beetles (*Scolytus ventralis)* and ambrosia beetles were also seen in recently killed trees. There also are a few grand fir with conks of *Echinodontium tinctorium*, punk knots, seams and cracks in the stems, and other evidence of heartrot. Conks of *Phellinus pini*, a white pocket heartrot were evident on at least one lodgepole pine. Tree failures were observed in several locations in the campground area; most resulting from root decay. Heartrot and, in one case, a stem canker were contributing factors in some of the tree failures. Direct standing tree mortality caused by root disease and bark beetles appears to be far more common than tree failures in this campground.

Root disease in Douglas-fir and grand fir is so common on Clearwater National Forest that it is rare to find stands of this age without significant damage. This makes management of campgrounds in these forest types difficult. While bark beetles are almost certainly selecting trees with advanced root disease, they will probably only kill a small proportion of the trees that have severe root loss. Therefore they are not good indicators of severely diseased trees. Roots are decayed slowly by fungi, and decline is a very slow process up until the last two or three years before a tree dies. For further discussion of root pathogen and heartrot biology and management, see Appendix A. Diligent monitoring of the campground trees and prompt removal of trees identified as potential hazards will minimize the probability of a tree failure leading to personal injury or property damage in Jerry Johnson Campground. To this end we tried to make this initial assessment as thorough as possible, providing a database and maps to expedite future re-evaluations of the trees.

Assessment Methods

We assessed the condition of all trees greater than 5 inches at breast height that were close enough to developed features of the campground to cause damage if they failed. The height of trees, projected to the ground, represented their potential hazard range.

We concentrated on the trees around developed sites and campground roads. We did not evaluate trees around the helipad and water well above the campground, nor the trail that originates in unit 14. We were unable to determine the intended locations of outhouses so these sites were not specifically assessed.

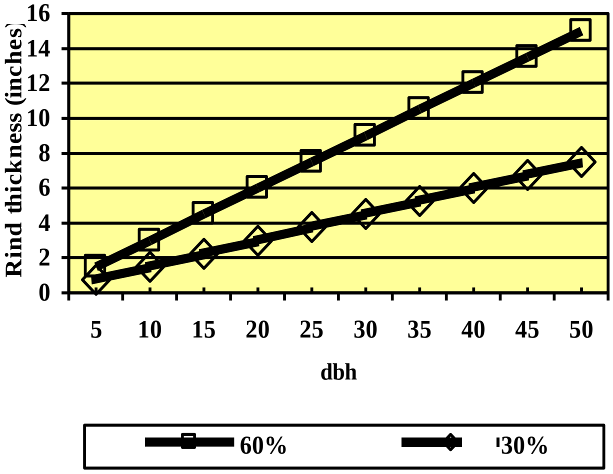
Mapping and scoring trees

The fire ring was used as the map center for each site. All trees within target distance of any developed feature of the site were mapped and scored. Map blanks (Appendix B) were used which divided the site into quadrants beginning with true north aspect and proceeding clockwise around the fire ring.

Species and diameter at breast height was recorded for each tree. They were scored for all significant damages and defects observed using six standard damage categories (Appendix C); decay, wound, canker, lean or sweep, branch or forking defects, root damage or disease. For each of these categories a severity range of 1-4 was applied, to make a combined code such as D3 (decay, severity level 3).

Where heartwood decay was suspected, trees were bored to determine the depth of sound rind. Trees with sound rind (outer xylem of the stem) depth of at least 60% of the radius of the stem are considered to be low hazard for failure due to the heartwood decay. Those with 60% to 30% sound rind are considered moderate hazard, and those with less than 30% have a relatively high probability of failure. Therefore we used the graph in Figure 1 to determine the severity rating for trees with heartrot.

Figure 1. Thickness of sound rind based on 30% and 60% of radius (inside bark).



Root disease was by far the most common damage observed in the campground with virtually all grand fir and Douglas-fir showing some level of root disease effects. Therefore, we used the root damage ratings only to indicate trees with particularly severe root disease symptoms. A rating of R3 indicated trees with significantly deteriorated crown condition, presumably due to root disease. R4 indicated trees that were in the final stages of dying from root disease, usually with associated bark beetles or ambrosia beetles (in grand fir). Root damage ratings of 1 and 2 root used to indicate physical damages (wounding and severing), generally associated with campground construction.

Wounds and leans were common as well. Most wounds were recent as a result of campground construction. Both were scored according to the table in Appendix C.

Determining targets

Many tree had more than one potential target. Standard target codes were as follows: 1 = occasional use such as trails or signs with no vehicle access (this code was not used in this assessment); 2 = intermittent use such as busy trails, the campground road and entry and day use areas; 3 = frequent use such as campsites, parking areas and permanent structures.

Trees with more than one target were assigned the highest code applicable. The exception was in the case of a lean value of 3 or higher. If the tree was leaning strongly away from the highest rated potential target, it was assigned the rating of the more likely target.

Action recommendations

Recommendation for removal was usually based on the probability of eminent death due to root disease or an unreasonably high probability of failure due to advanced heartrot or butt rot. We tried to identify only those trees most likely to die in the near future or those that had class 3 targets as well as a high probability of failure. In a few cases a combination of moderate root disease and a lean toward a class 3 target, root disease combined with moderate heartrot (and a class 3 target) or similar combinations of conditions resulted in a recommendation for removal. Trees thus identified were tagged with metal number tags at breast height facing the reference fire ring. The nails used to attach the tags were aluminum to ensure there would be no risk of saw or planer damage should the nail fail to be removed before falling or milling. We also flagged each tree recommended for removal to make them easy to spot.

Data handling

Data were recorded on field sheets and entered into a Microsoft Excel sheet for analysis using Microsoft Access. The maps were converted from hand-drawn maps to slides in a Microsoft PowerPoint presentation. Hand-drawn maps were electronically scanned to retain relative positions of trees around the fire rings and standard mapping symbols were added as location markers for each tree with color-coding for easy reading (Figure 2). Both the database and maps should be easily updated from these products for future assessments of Jerry Johnson Campground. If kept current, they should provide for easy tracking of campground trees in the future.

There were several campsites that were not assigned unit or spur numbers on the campground map we used as our reference in this assessment (Figure 3). Therefore we

assigned tentative numbers to these unmentioned units according to the nearest designated site. Units 9a, 9b and 12a were the new designations. A short stretch of roadside forest between units 3 and 4 was designated “unit” 3a, although there is no campsite. Also, the water fountain on the upper road was used as a map center and assigned a “unit” number 50. In the process of analyzing the data in Access, we found it necessary to assign numbers to units 12a, 3a, and 9b. These appear in the database as 51, 52 and 53, respectively. The map number can be used to assure a correct match between the original unit numbers and numbers assigned in Access.

Results of the assessment

We assessed 843 trees in 19 designated units and 5 additional developed sites. Twenty two unit maps were developed (as seen in Figure 3). Grand fir was by far the most abundant species (Table 1), constituting 88% of the trees. Douglas-fir made up only about 9% of the forest but were nearly all large trees. The four ponderosa pines were clustered in the center of the campground and were all very large and relatively healthy. The lodgepole pines have small crown ratios and may survive only a decade or two more; they appear to be quite old for the species.

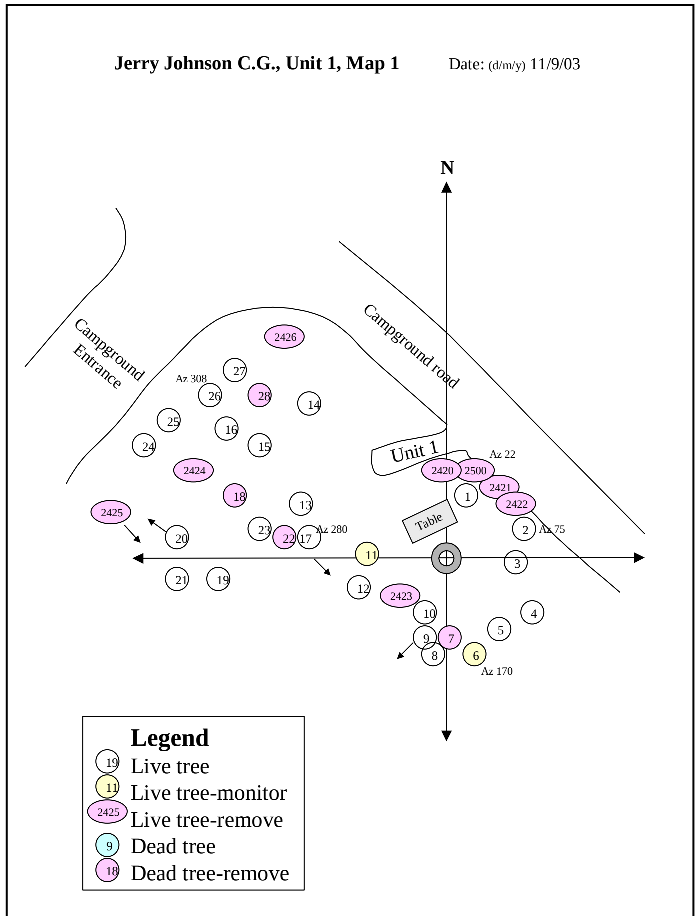


Figure 2. Example of unit maps stored in Microsoft PowerPoint format.

Table 1. Tree condition and recommended actions by species. (Based on September 2003 assessment.)

				Recommended Action	
Species	Total	Dead	Average d.b.h.	Monitor	Remove
Douglas-fir	75	7	20.9	8	33 (44%)
Grand fir	746	16	18.6	38	131(18%)
Lodgepole pine	17	2	14.8	0	5 (29%)
Ponderosa pine	4	0	30.5	0	0
Engelmann Spruce	1	0	8.5	0	0
All species	843	25		46	169 (22%)

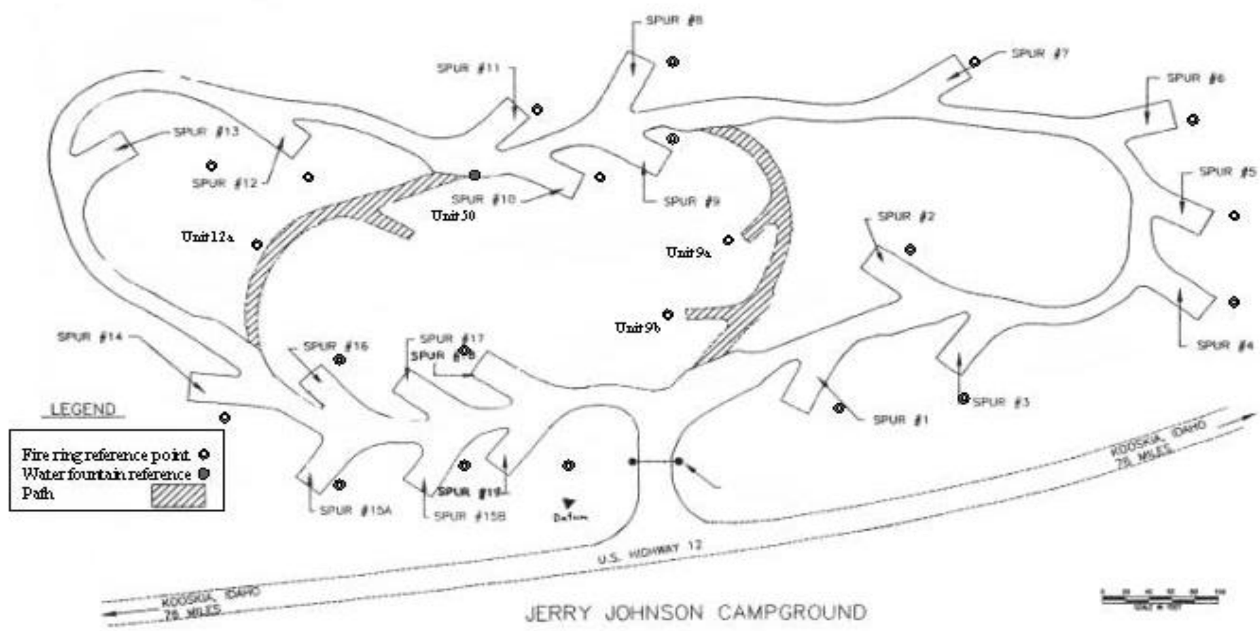


Figure 3. Map of Jerry Johnson Campground showing locations of unit map reference points.

Tree damages and defects

Of the few live Douglas-fir left in the campground, 57% have moderate to severe root disease; 37% are recommended for removal because they will likely die within the year due to root disease (Table 2). Grand fir is fairing a little better with 32% coded as having moderate to severe root disease and only 9% recommended for immediate removal due to root disease. There was, however a fair amount of decay caused by both Indian paint fungus and butt rot from annosum root disease. Between the two causes, 5% (37 trees) have moderate to severe decay. In a few cases, Indian paint fungus conks were observed high on the stem of grand fir, producing a high stem decay rating even though it was not possible to bore the tree for sound rind measurement.

The high level of recent wounding (30%) undoubtedly will contribute greatly to increased decay rates in this species. Cambial wounds are known to increase the frequency and extent of stem decay within a few decades of wounding (Aho and Filip 1982).

Heartrot caused by *Phellinus pini* was observed in one lodgepole pine in unit 12. There were numerous conks on the stem and the sound rind proved to be only 0.6 inches.

Frequencies of damages varied greatly among the campground units (Table 3). Units 1, 3, 6,14,15, 17 and 18 all border active root disease patches. The rates of mortality are especially high along the edges of these patches where fungus inoculum is abundant. Units 2, 6, 14 and 15 have both H. annosum and A. ostoyae active which undoubtedly increases the rates of mortality.

Table 2. Moderate to severe damages or defects observed on live trees with target codes 2 or greater. (Based on September 2003 assessment.)

Species	Total live	Root Disease		Stem Decay		Wounds		Leans	Other
		Sev 3	Sev 4	Sev 3	Sev 4	Sev 3	Sev 4	Sev 3	Sev 3 or 4
Douglas-fir	68	14	25	0	1	1	0	2	1
Grand fir	731	163	68	13	24	34	5	9	12
Lodgepole pine	15	0	0	0	1	0	0	1	3
Ponderosa pine	4	0	0	0	0	0	0	0	0
All species	818	180	97	13	25	35	5	12	16

Table 3. Severe damage codes assigned to *live* trees by unit. (Based on September 2003 assessment.)

						Recommended Action		
Unit	Total live	Root Disease		Stem Decay		Monitor	Remove	
		Sev 3	Sev 4	Sev 3	Sev 4		Trees	Percent
1	32	13	8	1	0	2	8	25
2	99	15	13	1	1	12	16	16
3	29	7	5	0	2	0	8	28
3a	15	6	1	1	2	0	4	27
4	44	17	2	0	2	1	6	14
5	29	13	1	1	0	3	6	21
6	41	22	10	3	2	2	15	37
7	44	13	6	1	2	2	13	30
8	20	1	0	1	1	1	4	20
9 & 9a	37	2	1	0	0	1	1	3
9b	43	5	1	0	0	5	1	2
10	24	2	2	0	0	1	4	17
11	39	1	8	2	2	0	11	28
12	41	1	0	0	1	1	1	2
12a	26	2	0	0	0	4	0	0
13	38	6	6	0	2	4	7	18
14	45	14	12	1	1	1	16	36
15	25	6	3	0	1	0	3	1
16 & 17	23	4	3	0	2	0	6	26
17 &18	45	6	9	0	1	2	12	27
19	52	7	3	0	1	1	3	6
50 (fountain)	27	4	0	0	0	3	0	0
All Units	818	167	94	12	23	46	145	18

Recommended actions

Overall, we recommended removal at this time for 22% (169) of the 843 trees we evaluated; 18% of live trees evaluated. A few of the units were hard hit. We recommended 37% of trees in unit 6 and 36% of trees in unit 14 for removal. For most units we recommended one quarter or fewer of the trees to be removed at this time.

We noted a need to monitor a few trees specifically because they were likely to require removal in the near future. In reality, it is difficult to pick the trees likely to die next from root disease and bark beetles unless they are very close to death already.

Most of the target codes assigned were in the highest class, 3 (Table 4). These were primarily the campsites themselves, including tent pads, tables, fire rings, and parking areas for the units. Of 843 trees evaluated, 88% were considered to have class 3 targets and as a result, 85% of the recommended removals are in class 3 target locations.

Table 4. Recommended actions by target code. (Based on September 2003 assessment.)

		Recommended Action	
Target Code	Total trees	Monitor	Remove
1	7	0	0
2	91	6	25
3	745	40	144
All	843	46	169

There was little variation in average diameters of trees by unit (Table 5). Most units are dominated by at least a few very large grand fir or Douglas-fir. Decay is also scattered through the campground but mortality is somewhat clustered at the edges of the root disease patches near units 1 and 3 and 14. High rates of mortality will likely continue in these units even after removal of the designated trees. Tree failures were noted in or near units 1, 3, 5, 6, 7, and 18. In all but three cases, the failure was due to root decay. Two trees near units 1 and 3 had failed because of advanced heartrot. One very large ponderosa pine near unit 6 had broken off high on the stem because of a gall rust canker.

In two cases, relatively small, dead trees were not recommended for removal because they appeared to pose little threat to campground users or facilities and they were host to cavity nesting birds. The trees recommended for removal ranged from a few small trees to several very large trees, as much as 36 inches d.b.h. Table 6 provides a breakdown of recommended removals by species and diameter classes. Of the 169 trees recommended to remove, nearly 60% are at least 16 inches d.b.h. and 78% are grand fir.

Table 5. All trees assessed and recommended action in each campground unit. (Based on September 2003 assessment.)

Unit	Total	Dead	Average d.b.h.	Recommended Action	
				Monitor	Remove
1	36	4	16.1	2	12
2	102	3	17.8	12	19
3	32	3	15.4	0	10
3a	15	0	18.7	0	4
4	46	2	18.8	1	8
5	30	1	17.0	3	7
6	43	2	17.7	2	17
7	45	1	20.5	2	14
8	21	1	16.6	1	5
9 & 9a	37	0	16.7	1	1
9b	43	0	17.0	5	1
10	24	0	15.9	1	4
11	39	0	14.6	0	11
12	42	1	14.2	1	2
12a	26	0	14.6	4	0
13	40	2	15.0	4	9
14	47	2	18.0	1	18
15	26	1	17.5	0	4
16 & 17	23	0	16.3	0	6
17 &18	46	1	15.2	2	13
19	52	0	14.1	1	3
50 (fountain)	28	1	16.7	3	1
All Units	843	25		46	169

Table 6. Number of recommended removals by species. (Based on September 2003 assessment.)

	Diameter classes (inches at breast height)								
Species	<8	8-11.9	12-15.9	16-19.9	20-23.9	24-27.9	>28	Max d.b.h.	Total
Douglas-fir	1	3	5	5	8	6	5	36.7	33
Grand fir	12	16	32	29	19	14	10	34.2	131
Lodgepole pine		1	4					15.6	5
All species	13	20	41	34	27	20	15		169

Management Recommendations

Removal of highest hazard trees before campground is occupied

These trees were mostly grand fir which, if they failed, would have tent or parking sites, tables, or fire pits as likely targets. They are trees that lean, show root heaving, or have heaviest crowns in the direction of one of these targets. Such trees have higher risk of causing property damage or injury in the case of failure. All trees have some risk of failure and trees with root disease are at an increased risk because of decay of structural roots. It is common practice in campground maintenance to remove trees with indicators of hazard (such as root disease or stem decay) with priority given to trees with human-inhabited targets.

Additional mortality should be anticipated as the disease continues to progress in remaining grand fir. Thinning will not improve the condition of the grand fir trees and few are likely to survive more than one or two more decades. Annual evaluation of the site and removal of dead or dying trees is likely to be required. Revegetation with species resistant to S-type annosus and Armillaria root diseases will be necessary to re-establish tree cover and restore the aesthetic qualities of the site.

Annual monitoring of all trees

A walk-through exam including reassessment of trees previously noted as needing monitoring should be done each year. A thorough assessment should occur at least every 5 years, at which time the database and maps should be updated. This will be especially important as decay begins to develop behind the wounds produced in the recent construction of campground facilities.

A vegetation management plan

A comprehensive vegetation management plan is needed for this campground because of the high rate of loss of existing trees. Continued removal without providing for replacement of trees will eventually alter the character of the campground. A few ponderosa and lodgepole pines are present near campsites. Both species are considered resistant (though not immune) to annosum and Armillaria root diseases as well as Indian paint fungus. The only regeneration observed in the campground in this assessment was grand fir. Few of these young trees have potential to reach maturity because of their susceptibility to root disease and the high levels of root pathogen activity on this site. Western larch is also resistant to root diseases and may be a suitable species for this campground. There are significant canopy openings in several units and if the recommended removals are done, there will be more. These openings may provide opportunities to plant disease-resistant trees.

Native hardwood trees and shrubs are not susceptible to either root pathogen observed in Jerry Johnson campground and may be useful for providing temporary screening until young conifers are established.

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Appendix A

Annosus root disease biology and management

There are two types of *Heterobasidion annosum* in Idaho that are distinguished on the basis of host range. The P-type, which causes its greatest damage in ponderosa pine, appears to be far less common in Idaho than the S-type. S-type, named for it's significance as a pathogen of spruce species in Europe, is a very common and damaging pathogen of Douglas-fir, grand fir and subalpine fir in Idaho. Western redcedar is also a common host to *H. annosum*, though it seems to survive infections for many decades. Although we have not determined whether western redcedar is host to P-type or S-type, it is most likely to be S-type based the presence of root disease in Douglas-fir and grand fir growing in association with infected cedar. Pines, western larch and hardwoods are resistant to S-type *H. annosum*.

The disease, as the name implies, mostly involves the roots. The fungus attacks the root cambium, girdling and killing roots. Once dead, the roots are decayed by *H. annosum*. The disease spreads throughout root systems and the fungus moves from tree to tree through root contacts and for short distances through soil or duff. In general, the disease kills Douglas-fir more rapidly than grand or subalpine firs. Thus, by the time grand or subalpine firs are visibly declining, the Douglas-fir component of stands has already been killed. Once established on a site the fungus is essentially a permanent feature of the site. They are long-lived organisms that can take advantage of the presence of hosts from one generation of trees to the next. They survive forest fires by slowly decaying root systems well below ground.

Stump surface infection can be an important means of spread of P-type annosum so management recommendations often include treatment of stump surfaces to prevent spread of the disease. S-type annosum is does not provide this opportunity. High rates of root infection exist in most Douglas fir and grand fir stands which render stump infection inconsequential. Partial harvest, leaving Douglas-fir, grand fir or subalpine fir is discouraged because high rates of mortality of leave-trees generally result. Mortality rates between 3 and 7 percent per year are common if apparently healthy Douglas-fir and true firs are left after harvest. (Rates are higher if symptomatic trees are left.)

Armillaria root disease biology and management

Armillaria ostoyae is one of several pathogenic species of *Armillaria*. It is considered to be the only significant pathogen of conifers in the northern Rocky Mountains. All native conifers in this area are susceptible to A. ostoyae but some are far more resistant than others. By far the most susceptible is Douglas-fir. Grand fir and subalpine fir are also quite susceptible, especially when growing in association with Douglas-fir. Most other species are only significantly susceptible at a young age, generally less than 20 years. Exceptions are trees which are "off-site", that is genetically unsuited to the site on which they have been planted. Western redcedar appears to be fairly susceptible at advanced ages or under stressful conditions.

Armillaria ostoyae clones are thought to be the largest and oldest organisms on earth. They can extend hundreds of acres in size and are thought to be several thousand years old in some cases. They are adapted to survive generation after generation of forests on a site. Though they are though to invade site very slowly, expanding only a foot/year or less from established centers, they are tenacious; virtually impossible to remove from sites once established.

Root disease patches typically have two or more species of root pathogens occurring at once, infecting the same trees and even the same roots. *Armillaria ostoyae* and *H. annosum* are common cohabitants of Douglas-fir, grand fir, and cedar forests in northern Idaho. Mortality rates from A. ostoyae are similar to those seen in *H. annosum* root disease.

Stem decay biology and management

Indian paint fungus, *Echinodontium tinctorium* and the white pocket rot, *Phellinus pini*, are thought to have similar biology. Infections are initially established in shade-killed branches. The fungus produces a “quiescent” infection in which it fails to progress much beyond the original point of establishment for some years. As the tree grows, the dead, infected branch stub is incorporated in the heartwood. Once surrounded by the no longer living, thereby no longer resistant, heartwood, the fungus begins to grow. It lives entirely by decaying the dead heartwood, never invading live sapwood.

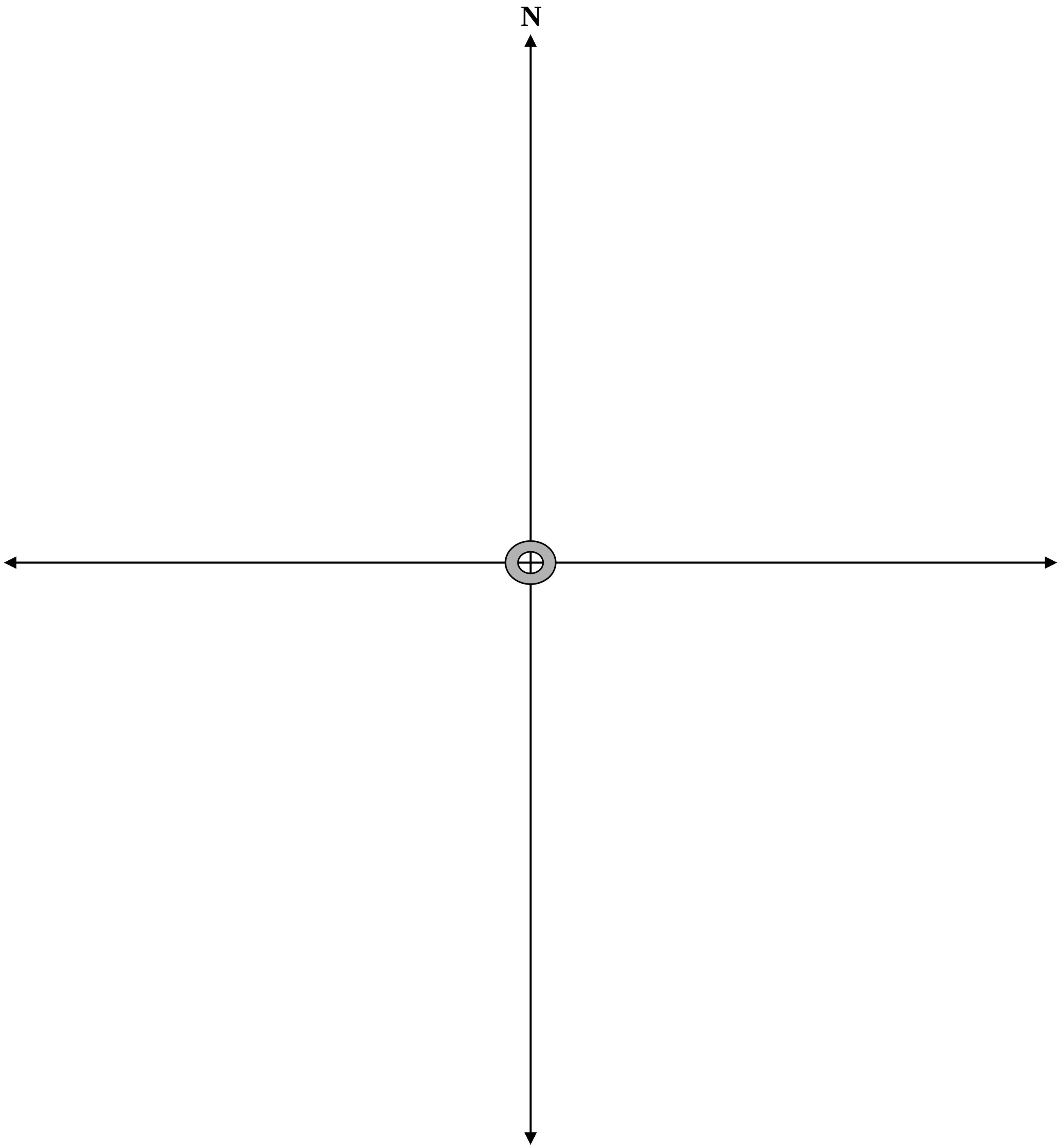
Decay caused by E. tinctorium can be especially extensive. A single young *E. tinctorium* conk may indicate a decay column extending 8 feet above and 8 feet below the conk. Larger, older conks may indicate 20 feet below and 21 feet above the conk. Two or more conks, widely separated on the stem, probably indicate that virtually the full length of the stem has a central column of decay. The longer the column is, the greater the width of the decay column. *Phellinus pini* decay is generally considered more limited in extent, extending about 3 feet in either direction from a conk. However, there are often many conks scattered throughout the length of the stem.

Wounds that kill a patch of cambium are known to greatly accelerate the extent and perhaps the rate of decay caused by Indian paint fungus. It is thought the dead tissue, which essentially becomes a part of the heartwood by virtue of being dead, increases aeration of the heartwood and improves growing conditions for the fungus. Whatever the cause, wounds are a highly significant factor in predicting decay volumes in grand fir. Infected overstory grand fir with stagnated understory grand fir provides the ideal situation for development of Indian paint fungus infection.

Appendix B

Site: ______________________ Date: day ____, mo. __, yr. _____ Unit ___________

Location of trees with respect to fire pit in each unit.



Appendix C

INSTRUCTIONS: Find the description of defect that most closely describes an observed situation and enter the severity code on the evaluation form. If three or more defects of the same severity are recorded for a single tree (e.g., 3D, 3W, 3L), the overall severity rating for the tree may be increased by one level (column A on the evaluation form). Your situation may not be described or exactly fit a description; the descriptions are simply provided to assist you in assigning an appropriate severity level for each defect. **Dead trees are automatically assigned a severity of 4.**

SEV. CODE	**DECAY OR CAVITY**: trees where significant decay is suspected should be increment bored to determine sound wood remaining (Rind) and excluding bark; severity may be influenced by tree species.
1D	Staining,, including wet wood, or incipient decay, but no advanced decay or fruiting bodies, no cavities.
2D	Advanced decay or cavities observed; sound wood (rind) >60% of radius; may have unusual pitch or watery slime seeping from cracks or openings.
3D	Advanced decay or cavities observed; sound wood (rind) 60-30% of radius (excluding bark); fruiting bodies may be present.
4D	Advanced decay or cavities observed; sound wood (rind) < 30% of radius; numerous conks or fruiting bodies or other defects.
	STEM DAMAGE AND WOUNDS: Lightning, frost cracks, mechanical, animal, human
1W	Cracks or wounds of any size but well-calloused or superficial, no decay
2W	Minor structural damage involving <10% of circumference; small cracks, fire scars.
3W	Some structural damage and associated decay; 10-50% circumference; large fire scars; severe cracks extending through stem.
4W	Multiple cracks or wounds causing severe structural damage and associated decay in > 50% of circumference; or movement detected in major crack.
	CANKERS: Blister rust, gall rust, dwarf mistletoe, etc.
1C	< 10% of bole girdled; burls of any size
2C	10-30% of bole girdled
3C	30-75% of bole girdled
4C	>75% of bole girdled or associated with other defects.
	LEAN/SWEEP: growth at the very top of the tree may indicate how long a tree has been leaning.
1L	Natural long-term lean <10%, fully compensated by growth (top of tree is vertical for many years).
2L	Natural long-term lean 10-15 degrees, fully compensated by growth (top of tree is vertical for many years).
3L	Lean 15-20 degrees or some indication of root movement (soil mounding, etc.), or associated with a canker.
4L	Lean >20 degrees with evidence of failure (e.g., obvious recent soil movement, root wrenching); associated with decay or cracks.
	BRANCHES, FORKS, WITCHES BROOMS AND TOPS
1B	Small dead or hanging branches or dead top <”; small witches brooms.
2B	Large brooms, dead or hanging branches or dead top 3-5”; unbalanced canopy due to poor pruning or multiple tops; codominant stems with no included bark.
3B	Dead or broken branches or dead top 6-9”; large condominant stems with included bark (weak union).
4B	Dead or broken branches or dead top >9”.
	ROOT DAMAGE, ROOT DISEASE
1R	Minor exposed roots, not sprung, no decay
2R	Exposed roots with minor damage or decay on small roots (<3”); no evidence of root disease.
3R	Substantial damage to roots >3” but <50% or root system affected; root disease suspected (slow growth, or other symptoms) but not obvious or confirmed.
4R	Exposed, decayed roots or substantial damage to roots >3” on >50% of root system; obvious root disease symptoms or signs (e.g., thinning, fading crown, stress cone crop, basal resinosus).